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Improving the Process for Mail Delivery Services

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Metropolia

Preface

I worked for three and half years as a specialist in the large Finnish company and I started thinking that Master's studies would be a boost to my knowledge. All my expectations and hopes have now come true, and I would like to thank my colleagues and my boss for their support for making this opportunity possible.

I would like to thank Dr Marjatta Huhta for this whole Master's process and her clear Thesis instructions that have been very useful to me. I would also like to thank Dr Thomas Rohweder for his very good advice and Jari Laine for the interesting discussions, support, and ideas for this research. Additionally, special thanks are going to Zinaida for her profound efforts and good support as for the structure and language of the Thesis.

Finally, I would like to express my gratitude to my fiancée Reija. With her support and understanding I was able to finish this Thesis on time.

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Metropolia

Abstract

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This Thesis investigates the challenges of the mail delivery services in the Finnish postal company. The postal sector is currently undergoing hard times. Mail volumes are steadily decreasing and electronic replacements, such as electronic invoicing, have become widespread. All these challenges call for improvements in the existing process of mail delivery services, which have become a focus of this Thesis. This study suggests a proposal of the model and develops recommendations for the case company. This model takes into account salaries for the employees, costs for the different delivery methods (cars, bicycles, and delivery trolleys), workings time costs in the delivery routes and delivery offices, resourcing employees, delivery for the sparsely populated area, and a new pricing model for mail. All these costs need to be taken into account, when developing a costs saving process for the mail delivery services.

Theoretical background of this study concerns supply chain management, data collection and database theory, and statistical reporting. The research methods, data collection and data analysis methods applied in this study are based on the action research approach. The data used in this study are qualitative and quantitative data. Qualitative data was collected from interviewing three people, experts on mail delivery services in different areas such as development, business case, transport, vehicles, corporate methods, and delivery process. Quantitative data was obtained from mail recipient database, i.e. statistics collection that is based on the mail volumes, delivery route optimization, and cost calculation information. After collecting the data, the current state analysis helped to map the existing process based on the interview data. The current state analysis also included the SWOT analysis of the existing process and overview of the additional challenges that the case company is coming across presently and is going to face in the future.

As its outcome, this study develops the proposal and suggests recommendations for the improved mail delivery process. Managerial implications are intended to help the case company to put this model into the practice. The recommendations also include suggestions for the process improvements that the case company could implement using the current tools presently in use in the existing mail delivery services.

Key words	Database, delivery services, route optimization, statistical reporting, social media, supply chain management

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Tiivistelmä

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Tämä opinnäytetyö tutkii haasteita postin jakelupalveluissa suomalaisessa postialan yrityksessä. Postiala on tällä hetkellä hankalassa tilanteessa. Postivolyymit laskevat tasaisesti ja sähköinen korvautuvuus, kuten sähköinen laskuttaminen on levinnyt joo laajalle. Nämä haasteet edellyttävät parannuksia nykyiseen prosessiin jakelupalveluissa, johon tämä opinnäytetyö on keskittynyt. Tämä tutkimus ehdottaa mallin ehdotusta ja kehittää suosituksia kyseiselle yritykselle. Tämä malli ottaa kantaa työntekijöiden palkkoihin, eri jakelutapojen menetelmiin (autot, polkupyörät, ja jakelukärryt), työaikakustannuksiin jakelureiteillä ja jakelutoimipaikoissa, työntekijöiden resursointiin, haja-asutusalueen jakeluun ja uuteen postin hinnoittelumalliin. Kaikki nämä kustannukset täytyy ottaa huomioon, silloin kun kehitetään kustannussäästöprosessia jakelupalveluille.

Tässä tutkimuksessa teoreettinen tausta käsittelee toimitusketjun hallintaa, tiedon keruu ja tietokanta teoriaa ja tilastollista raportointia. Tutkimusmenetelmät, tiedon keruu ja tiedon analyysimenetelmät sovelletaan tässä tutkimuksessa ja ne perustuvat toimintatutkimuksen lähestymistapaan. Tieto jota on käytetty tässä tutkimuksessa, ovat laadullista ja määrällistä tietoa. Laadullinen tieto kerättiin haastattelemalla kolmea henkilöä. He ovat kaikki asiantuntijoita postin jakelupalveluissa eri osa-alueilla kuten, kehitys, liiketoiminta, kuljetus, ajoneuvot, yrityksen toimintatavat, ja jakeluprosessi. Määrällinen tieto saatiin postin vastaanottajien tietokannasta, tilastojen keruusta jotka perustuvat postivolyymeihin, jakelun reittioptimoinnista, ja kustannuslaskentainformaatiosta. Tiedon keruun jälkeen nykytilan kartoitus auttoi kartoittamaan nykyisen prosessin joka perustuu haastatteluaineistoon. Nykytilan kartoituksessa on mukana myös SWOT-analyysi nykyisestä prosessista ja yleiskuva lisähaasteista, joita yritys kohtaa tällä hetkellä ja tulee kohtaamaan tulevaisuudessa.

Lopputuloksena tämä tutkimus kehittää ehdotuksen ja ehdottaa suosituksia parannetulle postin jakeluprosessille. Johtamisseuraamuksilla on tarkoitus auttaa yritystä laittamaan tämä malli käytäntöön. Nämä suositukset sisältävät myös ehdotuksia prosessin parantamiseen, jotta yritys voisi toteuttaa ne käyttäen nykyisiä työkaluja joita käytetään tällä hetkellä postin jakelupalveluissa.

Avainsanat	Tietokanta, jakelupalvelut, reittioptimointi, tilastollinen raportointi, sosiaalinen media, toimitusketjun hallinta

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Acronyms

B2C	Business-to-Consumer
COGS	Cost of Goods Sold
CR	Coverage Report
DB	Database
DBMS	Database Management System
DDL	Data Definition Languages
DML	Data Manipulation Languages
DSO	Days Sales Outstanding
ECJ	European Court of Justice
FTE	Full Time Equivalent
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GIS	Geographical Information System
HRM	Human Resource Management
SCM	Supply Chain Management
SQC	Statistical Quality Control
SQL	Structured Query Language
SR	Statistical Reporting
SWOT	Strengths, Weaknesses, Opportunities, Threads
UPS	United Parcel Service

1 Introduction

This Thesis focuses on improving mail delivery services and proposes a model to do it more efficiently. The new model is needed since mail volumes are going down, and the case company aims at cost savings. The topic has become relevant as the company is currently rethinking its mail delivery services and developing a process for delivery.

1.1 Overview of Postal Service Field

Campbell (2002) describes the postal sector of the modern global world in the following words:

> The postal sector is a multi-billion dollar set of activities that touches billions of lives daily and continues to be one of the world's largest employers. Until recently all Posts were monopolies owned by governments in order to maintain a universal postal service. However, in response to technological and international competition as well as public disenchantment with postal subsidies and inefficiencies, governments have embraced a range of new strategies. (Campbell 2002: i)

The postal service is often seen as a most profitable business, especially when it concerns such sectors as first class correspondence and bill paying. The fact is, however, that the postal service is now desperate to find new sources of revenue in new sectors to make up for projected future losses. Currently, it is being taken over by e-mails, faxes, online communications, and private carriers. As a result, many of postal services are striving to enter electronic commerce and other sectors far removed from delivering first and second class mail.

On a private level, individuals nowadays use e-mail and internet because it is linked to their PCs at home. Online retail sales continue to growing, led by enterprises like Amazon.com, which distributes books at significant discounts and organize their own shipments. Businesses can now process and coordinate own orders, bills, shipments, inventory and accounting. E-mail and internet have become a common means for routine business communications, with the largest part of e-commerce represented business-to-business transactions, rather than business-to-customer contacts. Those tools have changed the way communication is done.

However, these integrated and alternative forms of communications have not yet done away with physical materials altogether. Paperless offices are far in the future, and people still buy books and goods which have to be delivered. The communications and information revolution have not yet fully eliminated the needs for delivery services. The products must still be delivered to people by quick, reliable and cost-effective transportation providers. (Hudgins 2001: 2-4)

In the face of declining first-class mail and heavy competition in overnight and package services with such powerful private competitors as Federal Express (FedEx), Guaranteed Overnight Delivery and United Parcel Service (UPS), the postal service has two options: cut costs and/or seek new sources of revenue. In spite of many investments in new equipment and other labor-saving plans over the years, labor still accounts for about 80 percent of postal service costs. Thus, it is not surprising to find the postal service seeking new sources of revenue outside of the traditional first and second class mail delivery.

Presently, the postal services of the world are rapidly changing. They are privatized or commercialized, or everywhere their monopolies are deregulated. In a world where other industries, utilities, and telecommunications are being deregulated, postal service cannot remain immune to deregulation. Because the postal service confronts rivalry in competitive markets, large postal service losses suffer from this competition. A possible method currently suggested for making up for revenue losses is more subsidies from the states and directly from customers. (Hudgins 2001: 40) However, it leads to a situation when postal rates increase and the customers are even more unwilling to use them, thus creating a vicious circle for the postal services.

The Finnish Postal Services

The production of postal services consists of collection, sorting, transportation and delivery. Delivery is the final process stage which is consisted of for approximately 45% of the postal service provider's total production costs. This forms the major single cost item and it is most closely related to the regional circumstances in which delivery takes place.

The current daily delivery resource model in Finland involves two different econometrics methods: the *delivery cost model* defines how the volumes of product groups and

delivery conditions for delivery affect costs, and the *working-time model* defines daily delivery daily working time in relation to the volumes delivered. If mail volumes are defined well in advance, these models are used to illustrate the cost effectiveness of the service obligation, and the cost savings can be achieved.

For the purpose of postal deliveries, Finland is divided into 481 districts. All of the districts have its own delivery office, where preliminary work is carried out for the route deliveries. Delivery costs and working time include delivery work and the resources needed for work performed on the routes. Transportation to the delivery offices is not included in the costs being defined.

1.2 Case Company Background

The case company is a national mail enterprise solely owned by the Finnish State. The case company also operates in twelve other European countries. In January 2011, case company transferred its domestic postal services to its subsidiary and in February 2011, Finland became the first country in the world to receive all letters, publications, packages and direct advertisements through carbon-neutral delivery by case company. Remarkably, it does not involve any extra fees for the customers. The organization headquarters are located in Pohjois-Pasila, Helsinki. In 2010, net sales amounted to EUR 1,842 million, with case company providing work for around 29,000 professionals. (Case company 2012)

The case company is a service business company which core competence lies in information and product flow management for its key customers. Case company offers its corporate customers such solutions that enable them to enhance their competitiveness and run their business more successfully. Case company's key mission is to provide daily mail services nationwide in Finland.

As for its structure, the case company comprises three business groups. First, *Mail Communications* provides delivery services for letters, direct mail, newspapers and magazines nationwide, and through its partners worldwide. Case company is the only service provider for a nationwide delivery service every week day. Customer relationship marketing solutions offer efficient tools for building and managing customer rela-

tionships. There are also new developments, more diverse solutions for reaching customers both physically and electronically. This group also operates in Russia.

Second, *Information* offers financial process innovation as a service. This group is the efficiency of financial and accounting processes with readymade and modular services based on best practices. The necessary transaction volumes are to enable scaling effects in the case company. Automated and industrialized processes and the innovation competence are making the financial transactions management flexible and effective. This group operates in Europe and Russia.

Third, *Logistics* provides service logistics solutions for road, sea and air freight, warehousing services. It also completes contract logistics solutions and IT solutions. In eight European countries and in Russia, its logistics service network consists of over 30 offices. Again, the global services are offered through a partner network. (Case company 2012)

1.3 Research Problem

This study focuses on mail communication and its delivery services which allow delivering a mail to the customer five times in week. Being easy to describe in one sentence, this process, however, is quite challenging to organize in an efficient way. By now, every city and town has been split in different postal areas with the postal codes which are always five-digit in Finland. Some of the larger companies and organizations have their own postal codes. In addition, the address of mail recipient contains a company name, mail recipient name, street name, house number and apartment number, which is optional. According to this system, the person is considered a mail recipient, if the person's name is written before the company name in the address field of the mail. No other employee is allowed to open the mail but the indicated recipients themselves. Whereas the company is the recipient if the company name is indicated before the person's name, and any employee responsible for handling correspondence is allowed to open the mail.

Currently, the traditional delivery services process resources employees for delivery preparation by weight of the mail volumes and it does not observe mechanical refining

means. As a result, mail volumes and employees are not fully synchronized. Since mail volumes are now going down little by little, the costs are becoming unbearable for the company to sustain. Consequently, the case company needs to r-think the process and employees engaged in delivery services.

In the existing mail delivery process, mail delivery is split into different routes between delivery employees. These routes are re-designed too rarely, about once in half a year or even rarer. For example, when mail recipients move away from their current addresses, deliverers can skip those destinations though these delivery destinations stay in the route. As a result, the employees still keep getting the same salary after working a shorter time. Moreover, mail volumes are different in every day of the week, and they also differ from the month to month, but the employees' salary is unaffected by these changes as well.

According to the principles of the new mail delivery process, the number of stops and drops in the delivery route should be re-designed again and again, in order for the stop and drop times to be traced down and minimized. This is supposed to be done through the route optimization. Such improvement will decrease the existing delivery costs.

To implement this route optimization in practice, Statistical Reporting (SR) software is now available in the case company, which is able to trace down the mail volume that has been delivered by using special sorting technology. To achieve this, the company SR software is collecting data from mechanically sorted mail volumes. At the moment, however, that SR software is not used effectively. For example, the data can be gathered at the postal code level; and employees who are responsible for the mail volume statistics gather this data only for the amount of the daily mail volumes. As a result, designing and measuring the existing delivery routes are hard to be done, since there is no exact information how much mail is delivered to different postal codes. In a new calculation model, delivery routes need to be calculated to establish the coverage. If the mail volumes are going down, the coverage can be redesigned again.

The research problem, therefore, is defined around these activities and comprises the route design, vehicle system, resourcing employees, collecting data from the SR software, coverage reporting, and aims to eventually develop a model for the improved mail delivery process.

1.4 Research Question

The focus of this Thesis is placed on improvements for the mail delivery systems, route optimization, data collection, cost calculation model for working time, and supply chain management. It suggests a model in order to develop the coverage reporting tool that the case company can exploit to make its delivery services more effective and achieve cost savings. The model also re-thinks the employee engagement in a more effective way.

The research question of the study has been formulated as follows:

How to improve the mail delivery process to make it more effective?

The Thesis answers this question by combining knowledge acquired from the literature sources, benchmarks and analysis of the data from the existing mail delivery process obtained by qualitative and quantitative research methods.

1.5 Research Design and Structure of the Study

Figure 1 depicts how the research design applied in this study. The research question is answered through conducting the current state analysis based on the theoretical background for supply chain management, statistical reporting, data collection and database. These four topics form the framework behind the literature research and the overview of the existing data collection tools in this Thesis.

Figure 1 depicts the research design applied in this Thesis.

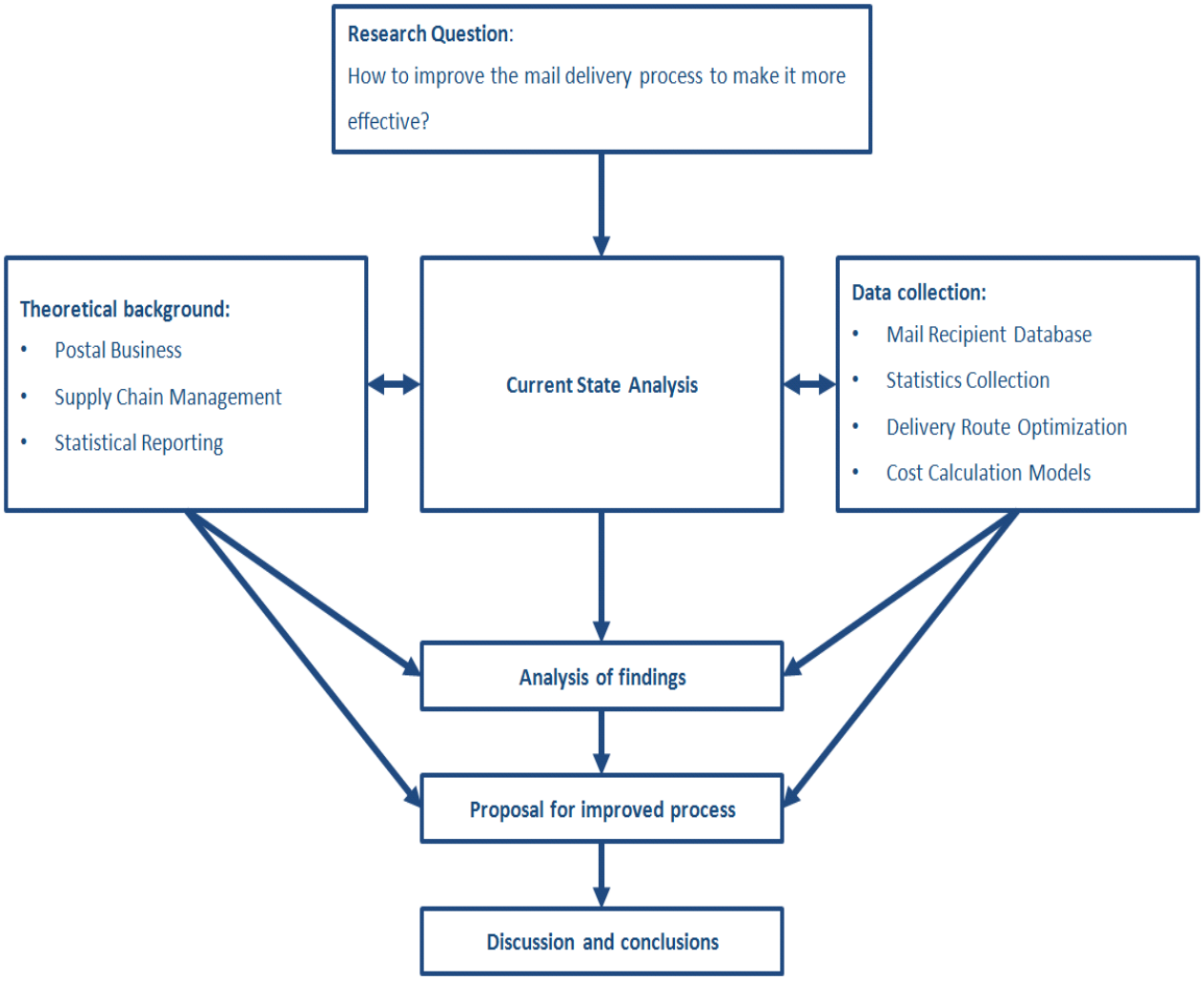

Figure 1. Research design.

As shown in Figure 1, the research design utilized in this study comprises three sources of data and information: theoretical background, data from the case company and the current state analysis, based on the developed framework.

As for the structure of this study, this Thesis is written in seven sections. Section 1, Introduction, presents the overview of postal service field, case company background, objectives of the study, defines the research problem, depicts the research design overview, and outlines the scope of the study.

Section 2, Supply Chain in Postal Sector, presents the challenges of postal business. This section also defines aspects for the new postal law, discusses the impact of social media, and overviews profitability of postal business. These challenges are overarching also other companies in postal business, not only the case company. Additionally, this

section focuses on supply chain management, statistical reporting, data collection and data analysis methods applied in this study. Based on the statistical methods, this section shows examples of statistical quality control.

Section 3, Method and Material, overviews the research approach that based on action research, analyzes the existing system based on the conducted interviews, and discusses the tools currently used for customer documentation in the case company. This section also defines the reliability and validity of the study.

Section 4, Current State Analysis, investigates the models and practices used for customer documentation in other organizations and those discussed in literature.

Section 5, Results and Analysis, investigates the challenges of mail results based on the case company interviews and the SWOT analysis of the existing process. This section shows examples of delivery route optimization, cost calculation, and statistics collection. It represents the main part of the Thesis findings.

Section 6, Proposal and Recommendations for the Mail Delivery Process, suggests a model for an improved customer documentation system, presents the results of its validation based on the interviews with the experts from the case company, and proposes an implementation plan for the case company Mail Delivery Process.

Section 7, Discussion and Conclusions, summarizes the results of the study, suggests a set of managerial implications and considers the future aspects of the mail services. The main emphasis of this study is placed on the systems specifications that is defined in Section 6. This was the most challenging part of the research.

2 Supply Chain in Postal Sector

This section is confidential and it will not be published in online publication.

2.1 Global Challenges of Postal Business

2.1.1 Letter Volumes and Forecasts

2.1.2 Impact of Social Media

2.1.3 Profitability of Postal Business

2.2 Supply Chain Management

2.3 Statistical Reporting and Data Collection

3 Method and Material

This section overviews the research approach applied in this study and introduces the data collection and analysis methods used for studying the data.

3.1 Research Approach

The research methods, data collection and data analysis applied in this study are based on the action research approach. The data used in this study are qualitative and quantitative data. Qualitative data was collected from interviewing three people, experts on mail delivery services in different areas such as development, business case, transport, vehicles, corporate methods, and delivery process. Quantitative data was obtained from mail recipient database, i.e. statistics collection that is based on the mail volumes, delivery route optimization, and cost calculation information.

In action research, the conventional social science research is, contrary to the traditional approach, is based on the relationship over the research subject, with one of the actors being the researcher and his personality. (Greenwood 1999: 29) The operating systems in action research are typically described in a view of the study, and it is not a method in the conventional sense of the word. Action research as an inquiry relationships, it refers more to the way of understanding and managing learning. According to Greenwood (1999), it is also the relationship between theory and practice, and relationship between the researcher and the researched subject/area.

3.2 Data Collection and Analysis Methods

The methods used in this study are interviews with the case company experts, database info, validation interviews with experts, and the researcher's personal observations.

When selecting a data collection method, one of the most important issues was to consider the type of the data to be collected, since some of the methods are more appro-

priate for collecting the data with the impact on business. Questionnaires, observations, interviews, focus groups, action planning and performance contracting, for example, are considered the best for these purposes. Though some of those methods are only suitable for application data; questionnaires, action planning and performance contracting can easily capture business impact data. (Phillips and Stawarski 2008: 143)

3.2.1 Interviews

The main body of the data is formed from the results of the interviews with experts from the case company. The current state analysis of the existing process is also based on these research interviews in the case company. With the results of these interviews, the existing process is then mapped to demonstrate the work of the existing mail delivery systems. The purpose of the interviews was to collect the data in order to identify typical challenges and risks based on the shrinking mail volumes.

The interview informants were selected based on the following three dimensions:

- Interview person 1: Development, business case
- Interview person 2: Transport, vehicles
- Interview person 3: Corporate methods, delivery process.

The backgrounds of the persons interviewed are presented below:

Interview person 1: Development, Business Case

The first person is currently doing the business case and investment counting, and optimizing the network, and is involved in the development program of mail communication. He has many years of experience in development processes and market forecasts of mail volumes. He is also familiar with statistical process control and measuring quality.

Interview person 2: Transport, Vehicles

The second person is currently responsible for the development of the vehicle system. He also has multiple years of experience in purchasing vehicles, competitive bidding,

developing driving style follow-up, and testing modern new vehicles. His background and knowledge fits very well with the research purpose, as he has experience in developing the vehicle and managing the administration systems.

Interview person 3: Corporate Methods, Delivery Processes

The third person represents the delivery process of the case company. He is currently in charge of the concept of delivery process and resourcing employees. He has over 15 years of experience in different processes in the case company. He is also very familiar with how different processes are connected together and how they influence each other.

Table 1 shows the interview dates and themes.

Person	Date	Interview Theme
Interviewee 1: Controller, Development, Business Case	10.02.2012	Costs, market forecast
Interviewee 2: Development Manager, Transport, Vehicles	05.03.2012	Vehicle concept, roles
Interviewee 3: Development Manager, Corporate Methods, Delivery Processes	08.03.2012	Delivery processes, roles

Table 1. Interview dates and themes.

All the interviewees were briefed on the topic and the purpose of the interviews by an email. The interviews began with a brief introduction of the topic and ensuring that they understand the themes and purposes of the research. Interviewees were conducted in person and the language of the interview was Finnish. The duration of each interview was approximately one hour.

The questions for the interviewees were present on the indicated topics and done by seeking examples from the interviewees' personal experiences (see Appendix 1).

All of the informants showed good understanding of the current state and demonstrated awareness of the complications of the mail delivery services. In the case company

situation, the future looks very challenging. Shrinking mail volumes, an increase in un-addressed mails, and emancipation of competition are among the main threats that negatively impact the case company processes. All these factors were mentioned by the informants in the research interviews. The views and opinions of the informants were taken account where developing a proposal for the typical mail delivery process.

3.2.2 Data Collection from the Database

The case company database that is referred to in this study is *the mail recipient database*. This study uses mail recipient and delivery point data from the database, and the data from the sorting machines for the statistics collection.

In the case company, the mail recipient address database architecture may be viewed, to some extent, as an extension of data modeling. It is used to conveniently answer requirements of different end-users from a same database, as well as for other benefits. For example, the financial department of the case company needs the payment details of all end-users as part of the counting the company's expenses, but not other details about them, that may be of interest to the marketing department. Thus, different departments need different aspects of the company's database that include both the personal and payment details, possibly in a different level of detail.

This study, as part of the data obtained from the database, also uses statistics from the case company statistics collection. In the case company, statistics is a range of procedures for gathering, organizing, analyzing, and presenting quantitative data. *Data* is the term for facts that have been obtained and subsequently recorded. And for statisticians, data usually refers to quantitative data that are numbers/digits. Analyzing numerical data in order to enable and maximize the interpretation, understanding, and use, statistics is also considered as a means of scientific inquiry. Eventually, statistics helps to turn data into information. The confusions comes from the fact that *statistics* as a technique used for handling quantitative data uses the same word as the statistics used to refer to the numerical results from statistical analysis. (Saunders and Brown 2008: 1)

In this study, the main data is represented by the mail recipient data which is a sorting code, always containing ten digits (see Appendix 3). This cod is important as a source

of data since all the delivery points are connected to sorting codes. The first five digits out of the ten show the information about the postal code and the last five digits show which sorting machine has sorted the mail. If the last five digits are over 10000, the sorting machine has sorted the mail to the delivery point level. If the last five digits are less than 10000, the sorting machine has sorted the mail only to the street level.

The function of the Statistical Reporting (SR) software is to collect the data from sorting machines (see Appendix 4). When the most important value of this data sorting is finalized, this data is going to be connected to delivery points. After that, it can be concluded how much mail is going to particular mail recipients, and the delivery route optimization can be suggested based on this data. With this data, the coverage report (CR) can be produce to the deliverer.

3.3 Reliability and Validity

Reliability is the analysis of failures, their causes and consequences (Xie et al. 2004: 7) and the quality is the most important characteristic of working before considering other attributes of research. If the performance is conducted on a certain level, the specific performance measures can be included into reliability analysis.

According to Cassell et al. (2006), the qualitative assessments, visions and technical quantitative studies are possible if done through careful analysis and if logical traps are avoided. The quantitative research and traditional natural sciences are typically considered superior to qualitative research. They are also hailed by scientists as the role model for rigorous and objective research. If quantitative analysis is grounded in calculations, qualitative and subjective assumptions are eventually based on interpretation. In the modern natural sciences, however, the qualitative and quantitative are more and more often running together. (Cassell et al. 2006: 168-169)

Validity of the research requires discipline and concentration on a present true picture, but is also equally dependent on convincing interpretations of the research data. The cross-validity of different kinds of evidence is the primary issue for validity as a technique. It is, for example, always helpful if the observations are written up as soon as possible and it is then more accurately recorded. However, it is the research discipline

that will determine if the data from observation, for example, is difficult to collect adequately, and if it is also troublesome to analyze. (Gillham 2010: 47-48)

According to Street and Ward (2007), the action research in the analysis process involves an extra step (reflection) which makes it distinct from longitudinal case studies, for example. In the case study, narrative timeline comes from the dataset. Despite the timeline in a case study, the issues of reliability and validity while both sources are address, treat reliability and validity as it applies to longitudinal timeline datasets. (Street and Ward 2007: 2)

4 Current State Analysis

This section analyzes the existing mail delivery system of the case company. It shows tool that are currently applied in the case company and maps the current process of the mail delivery services.

4.1 Tools Currently Applied in the Case Company

Currently, the case company utilizes a number of tools to make its existing mail delivery services more efficient. These tools include, among other systems, the mail recipient database, the delivery route optimization tool, and the cost calculation model.

4.1.1 Mail Recipient Database

A mail recipient database is an organized collection of recipients' data used for multiple purposes and kept in a digital form. The term "database" is sometimes narrowed to specify particular aspects of this organized collection of data and may refer to the logistics database or the computerized data storage, or some particular type of database content.

Presently, the mail recipient database is used to conveniently address requirements of its end-users, as well as for other purposes. For example, the financial department of the case companies needs certain payment details of the end-users or the logistics unit needs to specify the current addresses of the recipients. Thus, different departments need different types of information from the database, possibly on a different level of data detail.

4.1.2 Delivery Route Optimization Tool

To optimize its mail delivery, the case company currently uses the route optimization tool. However, an improved routing means more than simply directing a vehicle from one location to another. Optimized resource planning is also tailored for work sequenc-

ing, periodic updates of management tracking information, and dynamic and static routing. *Static routing* and work scheduling systems help service, repair and delivery of the case company to organize, plan and forecast the allocated tasks, deliveries and work orders. *Dynamic routing* is performed in real-time or near real-time and based on actual orders, *ad hoc* delivery changes and urgent requests. Some of the benefits of route optimization also include more efficient fuel consumption and improved customer service.

One of the basic parts of the current route optimization tool is represented by the geographic information system. A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. GIS is the merging of cartography, statistical analysis, and database technology, in the simplest terms.

GIS offer capabilities of integration multi-sector, multi-level and multi-period database. It is also a computerized database system for capturing, storage, retrieval, analysis, and display of systematic data. It is a technology for handling geographic data in digital form, and satisfying the following specific needs: 1) the ability to preprocessed data from large stores, 2) direct support for analysis and modeling, 3) post processing of results. Typically, the function of an information system is to improve one's ability to make decisions. An information system is the chain of operations that plans the observation and collection of the data, to use of the derived information in some decision-making process. (Reddy 2008: 222)

Figure 2 depicts a simplified information system similar to the system used in the case company.

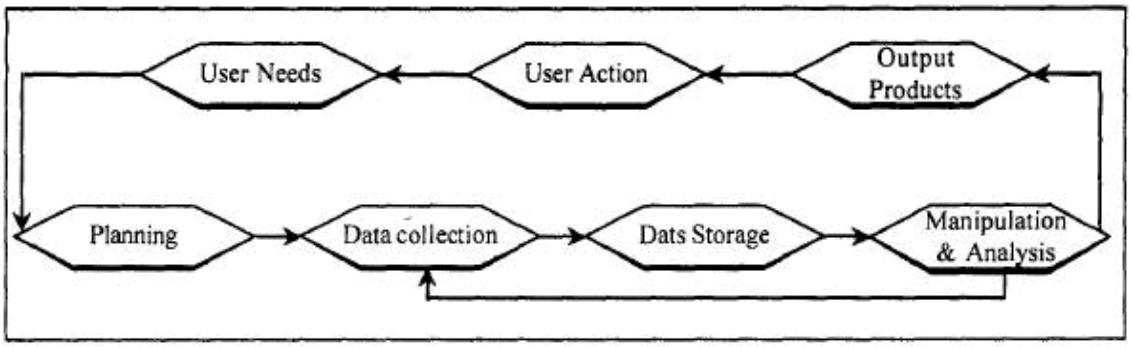

Figure 2. Simplified information system overview (Reddy 2008: 222).

As shown in Figure 2, GIS allows to collating and analyzing the information and can also be viewed as an integrating technology drawing upon and extending techniques that the case company uses about its end-users. In the case company, GIS have served an important role as an integrating technology, and GIS have evolved by linking a number of discrete technologies into a whole system that is greater than the sum of its parts. With GIS it is now possible to map, model, query, and analyze large quantities of data, all held together within a single database. Figure 3 depicts different stages of information transfer in GIS.

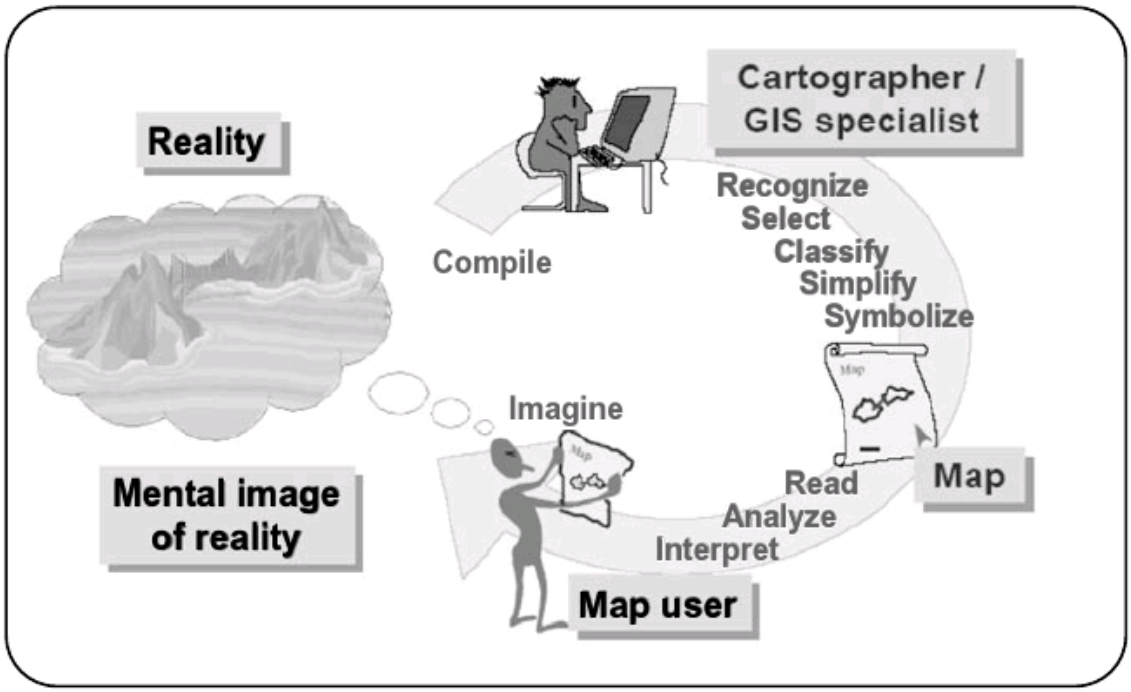

Figure 3. Information transfer in GIS (Fazal 2008: 6).

The positional data (raw data) is the starting point for every GIS by providing the basic geographic information needed for attribution, dataset modeling, relationships, and analysis. Raw data can come from a range of sources, such as aerial photographs, previously digitized maps, and global positioning systems. Other more labor intensive sources are field data and measurements collected from site visits, and transformed maps, and hardcopy maps are first scanned into a computer and then digitalized. (Galati 2006: 4)

In the case company, the existing mail recipient data (raw data in the mail recipient database) is the starting point for GIS providing the basic information needed for attribution, dataset modeling, and analysis.

4.1.3 Cost Calculation Models

According to Nikali and Elkelä (2010), this model that is currently in use in the case company combines the delivery resource model, the delivery cost model, and the working time model. All these models, however, are volume-based and depend on delivery of postal products which require delivery services. The differences of delivery costs, according to population density based models, is in the definition of postal services. For the correct resource allocation, these models should be connected to the advance information on the estimated delivery volumes, which would reduce costs, but which is not currently in place in the case company. (Nikali and Elkelä 2010: 7)

The structure of the econometric *delivery resource model*, applied in the case company, is calculated as follows:

$$y = a + bx_1 + cx_2 + \ldots + nx_n,$$

where: y = costs or working time, use of resources as a whole; x_1 = conditioning factors, e.g. population density, number of delivery points or length of delivery routes; x_2 ... x_n = delivery volumes for different product groups, e.g. addressed letter mail, magazines and newspapers or unaddressed mail.

In the *delivery cost model,* the delivery costs are determined by delivery conditions, the length of routes, and volumes of delivery according to different product groups. In the case company, fluctuations for seasonal variations are left out by using data for the whole year. In the *working time model*, the daily working time is calculated, including preliminary work at the delivery offices and the delivery work itself. The delivery volumes of the addressed letter mail, magazines, newspapers, and unaddressed mail are the explanatory variables in the current working time model (Nikali and Elkelä 2010: 27), as presently used in the case company.

4.2 Process Mapping of the Current Mail Delivery Process

The current process of the mail delivery existing in the case company is mapped to provide better visibility for the current problems. According to the interviews in the case company conducted in this study, the existing mail delivery system does not run effectively. Among the challenges, the interviewees named, for example, the current over employment and the needs for the routing system improvements. Another challenge is the target for costs savings that points to the needs to rethink the routing system and the resources allocated to improve the current situation.

The mapping of the current mail delivery process conducted in this study includes mapping of: a) productivity measurements, b) mail delivery specifications, c) existing vehicle system.

Productivity Measurements

The case company uses traditional measurements for measuring productivity in delivery service. Table 2 shows these measurements, described based on the study by Sartjärvi (1988).

Features of measuring delivery productivity:
> Shipments / time unit
> Distance / delivery
> Used time / delivery
> Costs / delivery
> Average of filling rate and utilization rate
> Reclamation / shipments
> Average load
> Average time of route
> Average length of route
> Delivery days / delivery person
> Average loads units / delivery day
> Average distance kilometre / delivery day

Table 2. Variables for measuring delivery productivity (Sartjärvi 1988: 100).

As shown in Table 2, the most basic variables used to measure productivity in the case company include shipment time, distance variable, cost delivery variable, and other variables typically used for productivity measurements.

Although it is typically quite easy to measure the information that depicts volumes and costs, measurement problems start when analyzing the actual service. For this purpose, there are three groups of variables that can be combined to measuring the service level, namely: time of the delivery, differences for the order and delivery, and reliability. Additionally, when motivation and work satisfaction in current working tasks are in good level, they are noticed to correlate strongly. (Sartjärvi 1988: 100-101)

Roles and Skill Requirements

In the case company, there are a number of roles in delivery services to which particular skill requirements are assigned. The roles currently defined for mail delivery service in the caser company are listed in Table 3.

Roles	Jobs	Skill Requirements
Service Manager	Confirms that the process is working on planned way and planned time. Responsibility of the delivery network in cost efficient way. Responsibility of over process limit working persons efficient use. Taking a part with sales and business to customer cooperation.	Overall knowledge of the Itella's products, processes and work intructions and being aware the meaning of contract delivery entering to Itella delivery business. Then also supervision of work needs to know how to guide delivery persons in process and work instructions. Control the external customer cooperation.
Production Secretary	Put together and store the salary bases.	Knowledge of the conditions of employment and systems.
Driver	Responsibility of delivering products for delivery persons.	Knowledge of products of contract delivery, transport process and work instructions.
Deliverer	Responsibility that delivery process is carrying out according to work and process instructions.	Knowledge of products of contract delivery, delivery process and work instructions.
Production Planner	Responsibility of optimizing the contract delivery network.	Improvement of the working pracices, knowledge of the process know-how and process design systems.
Work Mentor	Responsibility of guiding the working practice.	Knowledge of the working practices and working guidance.

Table 3. Roles and skill requirements in the case company.

As can be seen in Table 3, the roles incorporated in the mail delivery process of the case company, include *service manager* for the supervisor of the employees in delivery offices. *Deliverers* are doing the mail delivery job and *work mentor* introduces the job for the new deliverer. *Production planners* are an important role for this study, because they are also involved in the route optimization work.

Mail Delivery Specifications

In the case company mail delivery services, the mail delivery routes amount to about 270 000 km per day and 68 million km per annum. Currently, there are almost 7 000 delivery routes and 1 000 of those (15%) are over 100 km. Although the deliverers

have time to deliver multiple amount of mail in the city centre, the situation is different compared to more sparsely populated areas. The postal services of sparsely populated areas are upheld with the postage income coming from the large cities. 18 000 persons are currently working for postal service network. The current mail volumes reach 12 million mails per day and 3 billion mails per annum.

Figure 4 depicts an example of a supply chain for typical delivery services in the case company.

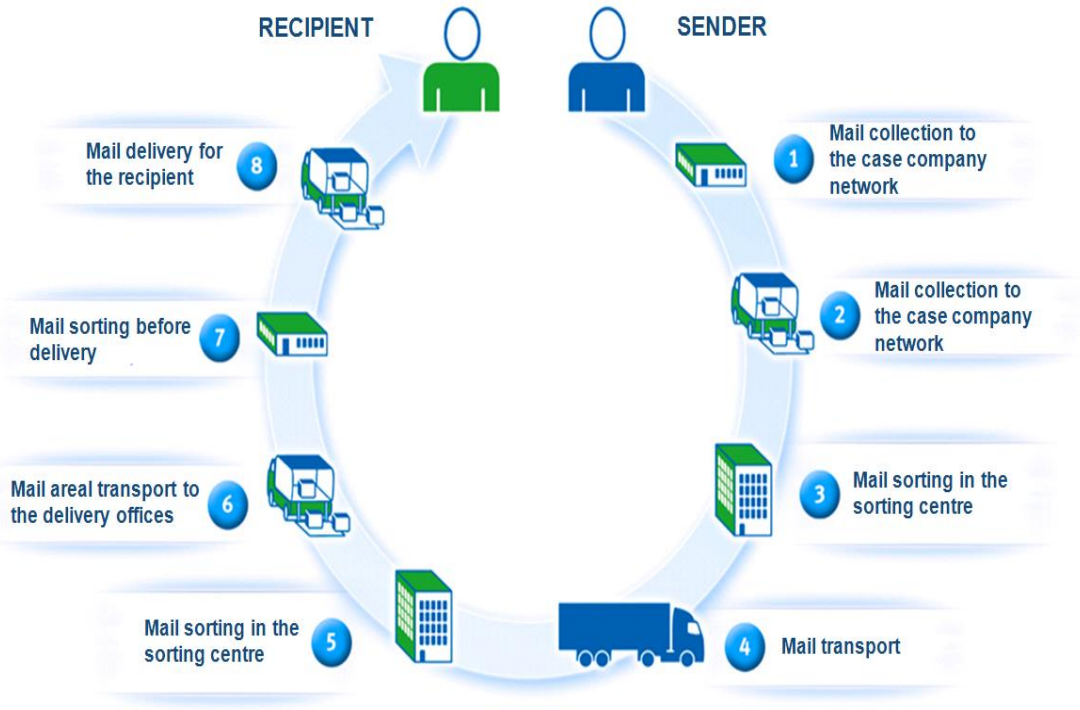

Figure 4. Supply chain for mail delivery services in the case company.

As Figure 4 shows, the main part of the supply chain is mail delivery for the recipient, although all parts of the supply chain take their effect on that. In this picture, mail sorting before the delivery in delivery offices is trying to do away with whenever possible. With sorting machines and mail sorting to the mail recipient level, much of such sorting can be eliminated in this part.

Existing Vehicle System

The case company has put into operation a special vehicle system so that vehicles can be used in an optimal way. This vehicle system defines the needs, purchasing meth-

ods, use and management in area, responsibilities and commitments, and instructions for the field.

Currently, there are about 34 000 cars in delivery services of the case company. Most of those are diesel-driven due to lower fuel consumption. It was calculated that a diesel-driven cars burns about 10 liters at 100km fuel, whereas petrol-driven cars burn about 14 liters of fuel for 100km. When a new car is purchased, it will typically have a six year contract drawn up with Fleet Innovation. Fleet Innovation is a Finnish company offering innovative car solutions. These solutions are cost efficient, which has been noticed by the management of company and financial administration. The company office is located in Otaniemi, Espoo (Fleet 2012). When purchasing a new vehicle, the organization makes a justified suggestion which includes the amount of the delivery (€/kg), length of the route (€/km), and personnel costs among other definitive elements. The case company needs to decide what type of the vehicle to acquire, in terms of: a) car, moped, or other vehicle, b) size of vehicle and transport capacity, c) equipment, d) traditional or alternative energy vehicle.

Table 4 shows the delivery stocks selection criteria for the vehicle when the type and method of delivery is chosen.

Delivery environment

	Densely populated area		Sparsely populated area	Length of the route	Maximum load	
Way to passage / delivery vehicle	Apartment house	One-family house		km/d	kg	m³
Trolley	+++	-	-	less than 5	50	-
Electric trolley	+++	+	-	less than 6	50	-
Bicycle	++	+++	-	5 - 15	50	-
Electric bicycle	+	+++	-	5 - 15	50	-
Moped 2 wheels	-	+++	-	10 - 25	50	-
Moped 3 wheels	++	+++	-	10 - 25	150	1
Electric vehicle < 3,5 t	-	++	-	20 - 40	400 - 500	2 - 3
Small delivery car (RHD, automatic transmission, < 2 t) and Small delivery car (RHD, automatic transmission, > 2 t, operating licence)	-	+++	++	more than 25	500 - 800	2 - 3
Large delivery car (RHD, automatic transmission, operating licence)	-	+++	++	more than 25	900	5 - 6
Car to sparsely populated area (LHD, < 2 t) and Car to sparsely populated area (LHD, > 2 t)	-	+++	+++	more than 70	500 - 800	2 - 4
Mailman's own car	-	-	++	max 70	500 - 800	2 - 3
Subcontracting	-	-	++	-	500	2 - 3

Table 4. Selection criteria for the method to make delivery.

As seen from Table 4, when selecting the vehicle, the following factors affect the selection. These factors are: a) purchase price + service cost = life cycle cost; b) availability, ergonomics, transport capacity; c) environmental aspect: consumption, alternative energy vehicles.

The selection also needs to take into account the procedure for ordering a vehicle. As a rule, such order is proceed in batches over five vehicles two times per annum. The funding deals and maintenance deals, which formerly were done together, were separated starting from 2010. In the case company, all of these functions are managed through TiNet – Vehicle Data Management System.

As for the roles and responsibilities, assigned to the vehicle system, they are listed in Table 5.

Roles	Jobs
Lead Buyer	Responsibility of purchasing vehicles. Shopping around vehicles, fuel, insurance, etc. Producing training material and work instructions. Responsibility of contents and updating vehicle concept and vehicle stock. Responsibility of informing related to vehicle concept
Area Manager	Responsibility of costs in own area vehicles. Accepts the invoices that has been placed on own area vehicles. Responsibility of cost efficient use of vehicles and areal training if needed. Responsibility of that personnel has got enough training for usage of vehicles.
Areal Contact Person of Vehicles	Responsibility of vehicles coordination and personnel support and areal training. Vehicles recycling in frame of kilometre limits. Responsibility of informing vehicle issues. Areal support. Coordination of operative activity. Main user for administration system Plan and prioritizate stations for vehicles, if there are changes in time of delivery. Report for the areal management (Area Manager).
Planner of Liabilities	Route planning and way to passage proposals for routes.
Service Manager	Responsibility of delivering order data of vehicles. Accepts the invoices that has been placed on vehicles. Every issues that has been related operative usage of vehicles.
Vehicle Manager	Responsibility of daily usage, inspections and services, input of kilometres, ordering fuel card from Vehicles organization and managing passwords, order of driver cards, checking driving licence of deliverers. Checking the invoices that has been placed on vehicles. Recycling of vehicles. Analyses of consumption report from administration system. CO^2 emission report per delivery offices. Knowing the conditions of different leasing contracts
Deliverer	Responsibility of appropriate usage of vehicles. Filling the notification of claim in accident
Vehicles Organization	National information for daily usage of vehicles, purchasing fuel cards, authorative issues, insurance issues, regular purchasing of vehicles and technical testing of vehicles.

Table 5. Roles in the vehicle system.

As seen from Table 5, there are many different roles in the vehicle system, but all the vehicles, type irrespective, need to be followed up closely. The function of the vehicle system is the optimal use of vehicles. The upcoming driving style tracking devices are intended to help with this. These devices, which are planned to be used in the case company, will collect the data on vehicles usage.

In the existing vehicle system in the case company, some of the deliverers use their own car for the delivery. In this case, deliverers get an agreed payment for using their own car and the deliverer is put in charge of the costs for the vehicle maintenance (fuel, damages, tows, etc.). Such a contract can also be cancelled in due time.

The use, planning and management are also an important part of this system, so that it is possible to have the right kind of vehicles for every purpose. Brand-specific instructions from maintenances and repairs need to be included in the new approach, as well as workshop activities, maintenances and repairs themselves.

Summing up, as demonstrated in this sub-section, these three elements - measurements, roles and responsibilities in the vehicle system - create the core of the mail delivery process in the case company. As for the current state of the mail delivery services in the case company, the existing mail volumes are going down little by little. Therefore, the case company has set goals and targets for the cost saving in the mail delivery process in the forthcoming years.

5 Results and Analysis

This section presents the results of the case company interviews. These analyses include the overview of the tools used in the case company, and show the challenges for the effective mail delivery process. This section also shows examples of delivery route optimization, cost calculation, and statistics collection.

5.1 Challenges of Mail Delivery

This section presents the results of the interviews and SWOT analysis of the case company as for the improvements to the current mail delivery services.

Results of the Interviews

According to *Interviewee 1*, *the cost calculation models* are effective tools for the resource allocation, if mail recipients in delivery routes, statistics of mail volumes, and seasonal variables in the mail delivery are well-known beforehand. With this data, the deliverers are able to perform their work in a more cost-effective way. In the cost calculation model, the challenges are represented, first, by counting costs of the overwork; and, second, if mails are not known well beforehand, these calculations may not be precise. The hope is that with using these cost calculation models the working time costs could be calculated more effectively, when the preliminary work at the delivery offices is kept at a low level.

According to *Interviewee 2*, the largest elements for the wasted resources are *the damages and accidents of the vehicles,* and *fuel costs* are also very expensive factor for the delivery services. As mentioned earlier, the mail delivery routes amount are 270 000 km per day, thus it is clear that the fuel costs take considerable effect on the delivery and transportation costs. In the existing vehicle system, the challenges are also the costs for damages and accidents; they are the largest cost group in the existing vehicle system. The hope is that the upcoming driving style tracking devices which are coming soon will improve the situation with the existing vehicle system. Importantly, every deliverer in this new system should be logging in to the system with his/her personal ID, otherwise the vehicle should not start.

According to *Interviewee 3*, the current delivery route optimization tool (GIS) needs to be exploited better. This improvement will need more resources for training and using this tool in the future. This, of course, will cause additional costs, but it is profitable in the long-term period. This Interviewee stressed that the delivery is the final process stage in case company, which accounts for approximately 45% of the total production costs of the postal service provider. In the route optimization, the main challenges are the learning of the GIS system. Again, it will take a lot of time and need resources. The opportunity here is that the GIS system will become an effective tool for the route optimization, when it is finally put into effective use.

The challenges, threats, weaknesses and opportunities of the existing practices in the mail delivery services of the case company are summarized in the SWOT analysis matrix. Table 6 shows the SWOT summary matrix based on the results of the interviews.

	Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
Delivery route optimization	Enables a comprehensive review, editing and analyzing of the data. It also enables delivery route optimization on the basis of needed data.	Needs a lot of resources and learning to use that tool takes a lot of time. Also applying data from the mail recipient database needs resources.	Can analyze and visualize data from mail recipient database and statistics of mail volumes. With this data delivery routes can be designed.	Mail recipients in densely populated area are moving often and "empty" addresses after the recipients moved out of them cause useless mail delivery.
Cost calculation model	Effective tool for calculating daily working time, length of delivery routes, and seasonal variations in mail delivery, if the relevant data for calculation is available.	It does not take account of the overwork and overwork is usual especially in peak days in mail delivery. Also requires that mail volumes are well known beforehand.	The model need to connect to the advance information on the estimated delivery volumes. With this model, the correct resource allocation is possible.	Seasonal variables, for example election mail, tax mail or Christmas cards are confusing these calculations. Also bad weather in winter is confusing these calculations.
Vehicle system	There are many different roles in vehicle system and all of the vehicles need to follow up closely. This is in good condition on the case company.	The largest elements for the wasted costs are the damages and accidents of the vehicles. These are also caused extra work for those, who take care for vehicle repairs.	The driving style tracking devices are soon to be installed for the vehicles. Then it is easy to follow, which deliverers need more information for the safe driving.	Nowadays, the fuel is quite expensive. Electric and natural gas cars would be most cost-effective, but transport capacity is not sufficient because of small cars.

Table 6. SWOT analysis of the existing process.

As seen from Table 6, *the treats* of the case company have been fairly topical issue already a few years by now. *The strengths* of the case company are based on in long-term trust from its customers. The case company is still leading the way in the postal sector in Finland, because of its two centuries of experience. So far, it has had the most comprehensive delivery network, effective basic services, wide service array, and a range of possibilities to produce customer-specific additional value services. These things are creating strengths for the case company for many years ahead, although in other issues the case company has come to the transition point at this time.

Overall, based on the result of the SWOT analysis, the case company is expected to run through major changes in the next few years. Therefore, the case company needs to maintain profitability and probably try new tools such as social media, because it is definitely the thing of the future.

5.2 Delivery Route Optimization

As for the delivery route optimization, the deliverer usually has a delivery route, which he/she covers every day. Figure 5 shows an example of a delivery route optimization.

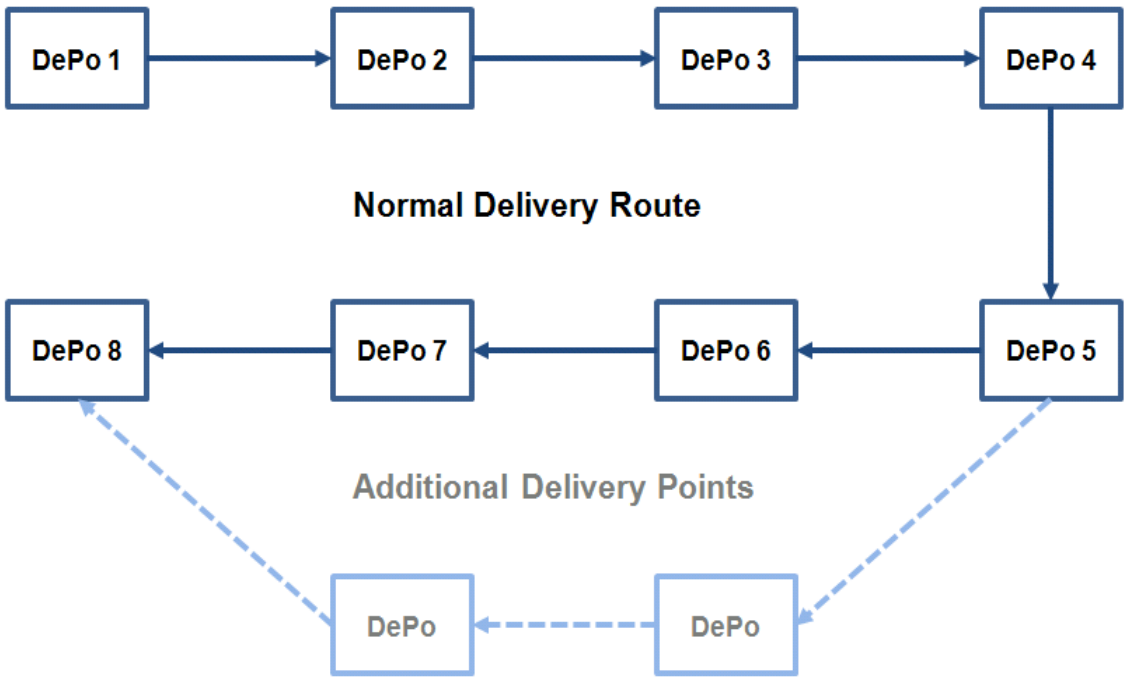

Figure 5. An example in delivery route optimization.

As shown in Figure 5, in a normal delivery route that is marked dark blue in the picture, the coverage is 100 %. If, for example, Delivery Points (DePo) 6 and 7 stay away, because they are left without mail, the coverage percent goes down to 83,33 %. In the improved mail delivery system, the deliverer could enhance his/her delivery route, and could deliver mail to additional delivery points. This will create cost savings if the deliverer's delivery route could be increased.

5.3 Cost Calculation

This section shows two examples of applying the cost calculation model. The first example shows calculations for a normal delivery route, and the second example shows the same calculations for the improved delivery route.

Working time in a delivery route (formula):

$$\frac{s}{v} = t \qquad\qquad t \times \frac{€}{h} = €$$

where: s = length of delivery route; v = speed in delivery route; t = time in delivery route.

Example 1. The working time in a normal delivery route (calculations):

If the length of delivery route in area 00770 is 3,2 km, the average speed in the delivery route with a delivery trolley is 6 km/h, and the cost of the deliverer's work for the case company is 20 €/h, then:

$$\frac{3{,}2km}{6km/h} = 0{,}533h \qquad\qquad 0{,}533h \times 20€/h = 10{,}667€$$

Example 2. Working time in the improved delivery route (calculations):

If the length of delivery route in area 00770 for the enlarged route is now 4,4 km, with the speed in the delivery route with a delivery trolley and the cost of deliverer's work for the case company being the same, then:

$\frac{4{,}4km}{6km/h} = 0{,}733h$ $\qquad$ $0{,}733h \times 20€/h = 14{,}667€$

Working time in a delivery point (formula):

$$t \times DePo \times \%$$

where: t = time in delivery point; DePo = amount of delivery points; % = coverage percent.

Example 1. Working time in a delivery point:

If the time in a delivery point is 8 seconds, the number of delivery points is 150, and the coverage is 100 %, then:

$8s \times 150 \times 1 = 1200s$ $\qquad$ 1200s = 20min

Example 2. Working time in a delivery point:

If the time in a delivery point remains the same, the number of delivery points is 90, and the coverage is 60 %, then:

$8s \times 90 \times 0{,}6 = 432s$ $\qquad$ 432s = 7,2min

As can be seen from these calculations, the coverage percentage makes a significant impact on the deliverers' working time. If the coverage is 100 %, the deliverer's working time is full, but if the coverage is lower than 100 %, the deliverer's working time is less. Then, the delivery route could be enlarged, and the deliverer could deliver mails for additional delivery points.

5.4 Statistics Collection

This section shows an example of how statistics of mail volumes are collected. There is a lot of information available but the most important statistics are how mail volumes are separated into different postal code areas.

Appendix 4 shows that totally in areas 00250, 00320, and 00770, there are 14 217 pieces of mail, sorted out and finalized. When mail is finalized, it means that the mail is sorted to the delivery point level. Appendix 3 shows how sorting codes are collected from the mail recipient database. Appendix 2 shows an example of how cost savings are calculated in one postal code area.

Table 7 shows the example that is focused on area 00770 only, so that areas 00250 and 00320 are separated from the amount of the finalized mail (14 217 pieces). When sorting codes and finalized mail to area 00770 are connected, then the deliverer can see how much mail is going to different delivery points.

Table 7 shows the example of such a coverage report.

Delivery Points	Sorted Finalized	Delivery Area
3182	3486	00250
6981	6950	00320
3562	3781	00770

Table 7. An example of numbers from a coverage report.

As can be seen in Table 7, there are many delivery points in densely populated area 00770. And it makes impact on the cost savings, if one deliverer could deliverer more mail for additional delivery points. These statistics are valuable for resource allocation, especially for the calculation of how many deliverers are needed to deliver mail in all delivery routes in different postal code areas.

Summing up, challenges of mail delivery results have been defined based on the interviews and SWOT analysis of the existing mail delivery process. The examples of delivery route optimization, cost calculations and statistics collection are done to demonstrate the costs saving opportunities in the mail delivery process.

6 Proposal and Recommendations for Mail Delivery Process

This section presents the proposal and recommendations developed based on the current state analysis and the suggestions collected from the interviews in the case company. This section also shows the recommendations that are based on the researcher's views.

6.1 Suggestions for Process Improvements

Based on the results of the Current state Analysis, the suggestions for improvements can be grouped around the following three topics.

First, in *the delivery route optimization*, the existing geographical information system needs to been exploit better, which would allow for designing well-grounded, cost-efficient solutions. One of the current challenges is that recipients in densely populated area are moving fairly often and "empty" addresses after the recipients moved out typically cause useless mail delivery. To overcome this challenge, the suggestion may be that delivery routes should be designed according to the most recent information, in real time, with applying geographical information system, in real time also. Here, the costs savings could be attained, for example, if delivery car drives along not the same routes, but different route in different days. Also, monthly peak days must be taken into account and handled separately. By using a sensitive tool, mail volumes could be linked more effectively to the mail recipients, and the coverage report can be timely provided to the deliverer.

Second, in *the cost calculation model,* the delivery resource model can be used as a basis for the resource allocation. However, the challenge currently is that it does not take into account the amount of overwork. The existing practice suggests that overwork is usually unprofitable, and, if it is needed, it causes additional costs. To overcome this challenge, the suggestion may be that, in the working time model, the overwork needs to be taken into special account. With the lower overwork costs, the work profitability will be higher. An alternative option is to raise a price for the mail, but it is much harder to execute, because the Ministry of Transport and Communications will not necessarily accept that.

Third, in *the existing vehicle system,* the largest elements for the wasted costs are the damages and accidents of the vehicles. The existing reports suggest that the fleet cars are used without any pity by deliverers; with tires and brakes services, and fuel consumption being high. To overcome this challenge, the suggestion is that, for the vehicle system, there should be a system of bonuses per delivery introduced which would offer a premium if the fleet cars are kept in low level of damage and accidents. Also, the special driving style tracking devices are soon to be installed for the vehicles. It is important that, in those devices, a login with personal ID should be used, or else a vehicle does not start unless those driving style devices are activated personally in some other way. Finally, the case company needs to think about introducing electric and natural gas cars, since they most cost-effective. The challenge, however, presently is that these cars are still quite expensive. Currently, there are only small cars are utilized using these power sources, and they are too small for the efficient delivery process. Therefore, the structure of vehicle fleet must also be looked into to check and rethink if there are suitable vehicles in different routes.

Table 8 summarizes the improvement suggestions for the three areas above.

	Suggestions for improvements based on interviews	**Suggestions for improvements based on researcher's observations**
Delivery route optimization	Design cost-effective delivery routes based on working time cost calculations.	Design delivery routes based on geographical information and the most recent situation in real time.
Cost calculation model	Take into account overwork in the working time model.	Improve information usage e.g. raise mail price based on population density.
Vehicle system	Install driving style tracking systems into operation.	Give bonuses for delivery offices that having low level wasted costs.

Table 8. Suggestions for process improvements.

Table 8 shows the suggestions for process improvements that based on interviews and researchers observations. Here, the existing geographical information system is suggested to be exploited better, which would allow for designing well-grounded, cost-efficient solutions. The suggestion may be that delivery routes should be designed according to the most recent situation, in real time, with applying geographical information system, in real time also.

Additionally, the existing cost calculation model does not take account of the overwork. In the working time model, the suggestion is that the overwork needs to be taken into account. With the lower overwork costs, the work profitability will be higher. Raising a price is suggested for the mail and evaluating better differences of delivery costs according to population density. Information on delivery volumes reduces costs can also be estimated, if the correct resource allocations are made.

The driving style tracking devices are suggested to be taken into operation. In the future, electric and natural gas cars instead diesel and petrol cars can be recommended for use because of their cost-effectiveness. It still needs to wait, however, when they become somewhat cheaper. Bonuses are also suggested for the delivery offices having a low level of fuel consumption, damages and accidents. This will be part of starting an environment and safety campaign, and this campaign could help avoid wasted costs.

Table 9 overviews the process improvement suggestions for *the measurements*, as well as for the *roles and skills requirements* which are developed based on the case company interviews and the researcher's own observations.

	Requirements for improvements based on interviews	Requirements for improvements based on researcher's observations
Measurements	Calculate the coverage for the delivery route that based on mail volumes for the mail recipients.	Equalize the mail volumes for deliverers in densely populated area.
Roles and skills requirements	Change the resourcing employees that based on mail volumes for the mail recipients.	Resource employees into the production planning for densely populated area.

Table 9. Requirements for process improvements.

As can be seen in Table 9, the process improvements are presented in two groups, those devoted to the measurements and those concerned with the roles and skills requirements.

For *the measurement*, calculating the coverage for the delivery route is required based on mail volumes for the mail recipients. After that, the deliverer can avoid those mail recipients' destinations where there is no mail to be delivered. The mail has to be delivered in different delivery routes, on different days. Equalizing the mail volumes for deliverers is especially required in densely populated area, so that overwork could be avoided. This could result in approx. 5-10% costs savings.

For *the roles and skills* requirements, in this mail delivery concept, resourcing employees is required to be based on mail volumes, too. Applying the cost calculation model with the length of routes, numbers of mail recipients, and mail volumes can help calculate the correct resource allocation. Additionally, more resources are required for the production planning for densely populated area to learn the current route optimization tool (GIS). Delivery routes can be designed again based on mail volumes, in real time. Statistics collection from sorting machines will show the mail volumes for the different postal code areas.

6.2 Proposal of the Model for the Improved Mail Delivery Process

As it was demonstrated in the Current State Analysis section, the existing mail delivery process cannot be considered effective in terms of the currently practiced resource allocation. Presently, the resource allocation is based on *the weight* of mail volumes and it does not take into consideration any mechanical refining.

Nevertheless, the statistics collection from sorting machines is an important part of the mail delivery process, because, at present, with the options provided by the modern sorting machines, the mail volumes can also be sorted for the deliverer in order of delivery. Since mail volumes and delivery points can be linked together, it can then be easily established how much mail is going to different mail recipients, before the start of the actual mail delivery. That is, the routes and volumes can be identified at the point when the coverage report for the deliverer is being formed. With this coverage report, the deliverer could easier plan his/her delivery route for the whole mail delivery. Being able to optimize the route, the mail delivery service can achieve costs savings through the savings of the working time at the point when the delivery is only about to start and none of the mail is delivered. At this point, it is possible to optimize the personnel allocation and, thus, make the overall service more cost effective.

Figure 6 depicts the proposed model for the improved mail delivery process.

Figure 6. Proposal of the model for the improved mail delivery process.

As can be seen in Figure 6, the improved mail delivery process will start from mail collection to the case company network and then mail will go to the outward sorting into the sorting centre. Inward mail is transported to the inward sorting centre and sorted second time in inward sorting. After inward sorting, statistics of sorted mail is available. Collecting statistics and proceeding delivery route optimization based on mail volumes is done before mail is transported to the delivery offices. With modern sorting machines, the mail sorting before delivery in delivery offices will be easier than before. Then, coverage report of delivery route for the deliverer is available, and he/she knows how to deliver mail more effectively in the route. The final part in the model is the actual mail delivery for the mail recipient.

As it can be seen from the suggested model, the improvements concern the following areas. First, the statistics collection from the sorting machines is done *after* the statistics from inward sorting are available. Second, the route optimization is going to proceed with GIS software based on the existing mail volumes. Third, in the improved model, the coverage report is based on the statistics from the existing mail volumes and is linked to the delivery points. Finally, the coverage report should be available before the deliverer is going to start on his/her delivery route.

6.3 Recommendations for the Mail Delivery Services

There are a number of recommendations for the delivery services based on the mail delivery interviews and the researcher's own suggestions.

1. The consumer supply and demand of the services does not match anymore. This leads to the conclusion that there is an oversupply in the market at the moment. This would lead to *reducing delivery days*, for example, to three or four days a week, which will not disturb the consumer. Part of the mail could be used *in electronic format*, with the rest as physical mail.

2. As mentioned earlier, *the postal services for sparsely populated areas* are upheld with the postage income coming from the large cities. For example, if one delivery point is located in 100 km away from any other delivery points, the postal services should make a deal with customer. For these customers, the delivery should take place only once a week to deliver all the mail from a week period. This arrangement will save a lot of fuel costs, even if this customer gets the mail free of charge.

3. For *the delivery route optimization*, it is an effective tool for editing and analyzing the data. Dynamic routing is performed in real-time or near real-time mode and based on actual orders. This means that there should be a production planner in every delivery office, who is doing the route planning and optimization. Otherwise, the route planning and optimization may not succeed in real time, if this work is done centrally in the case company's head office. Also communication with production is more difficult if done through the head office.

4. For *the cost calculation model*, it is an effective tool for calculating daily working time, length of delivery routes, and seasonal variables in mail delivery. This model is used mainly in the unit that produces research publications in case company. This model could be exploited better in delivery offices so that service managers can resource deliverers better for delivery routes. It is also important to obtain statistics of the mail volumes, and the production planner could do this work as well.

5. For *the existing vehicle system*, the diesel-driven car burns about 10 liters at 100 km of fuel, whereas petrol-driven car burn about 14 liters of fuel for the same 100 km. Fuel consumption is high because there are typically lots of stops and drops. The rate of stops and drops is a very influential element for the fuel consumption. In densely populated areas, the fuel consumption could be even more than this average consumption. Delivery route optimization will play a very large role in densely populated areas and it should be specially pointed at these areas. This will require resources, but the benefits of the route optimization are expected to be higher because the number of the stops and drops could decline.

These recommendations are developed for improving the process of the mail delivery services in the case company. Cost saving aimed at as an outcome from these improvements can become especially valuable in these hard times that continued already for a few years.

7 Discussion and Conclusions

This section presents the results of the study, including the executive summary, managerial implications, and evaluation of the study, including its reliability and validity. Finally, some future aspects for the case company are discussed.

7.1 Executive Summary

This Thesis has focused on the process of mail delivery services, and analyzed the problematics of the current process. The main part of this Thesis is comprised of current state analysis that has investigated delivery work, mail volumes, vehicle system, and also benchmarked different postal companies in Europe. This study provides suggestions for the process improvements that are based on the interviews with the experts and the researcher's own observations. The proposal of the model for the improved mail delivery process, statistics collection of mail volumes and delivery route optimization implemented before the actual mail delivery are the new parts of the improved mail delivery process. After this, the coverage report for the deliverer can be provided based on that data. The recommendations for the mail delivery services concern only the mail delivery and they are extended to include the managerial implications on how best put the suggested process into practice.

Section 1 in this Thesis introduced the case company which is widely known in Finland, because it has worked for a long time and it provides domestic postal operations. Theoretical background of this Thesis has focused on supply chain management. It is an important part of mail delivery services that is involved in every step of the mail delivery process. Theoretical background has also focused on statistical reporting, data collection and database theory, especially on the statistical reporting and data collection of mail volumes. Resource allocation and delivery route optimization could not succeed if mail volumes are not well known before the actual mail delivery. Database is another significant part of the mail delivery process, since people's addresses are changing all the time and the mail recipient database has to link with the mail volumes so that deliverer could know how much mail are going to different delivery points in delivery route.

Section 3 focused on research approach, data collection methods, interviews and reliability and validity issues. Research approach introduces the method used in this Thesis, which is action research. Action research focuses on relationships between theory and practice which is taken into special account in this Thesis. Data collection methods introduce how the data was collected for the coverage report and how this quantitative data was analyzed. With the results of the interviews from the current state analysis, the existing mail delivery process was mapped based on the qualitative data. The purpose of the interviews was to collect opinions in order to identify typical challenges and risks as for the challenges of the mail delivery services.

The current state analysis introduced the overview of postal service field in Finland. This part paid special attention to electronic invoices, internet and online retail sales that affected the postal services. Second, this section overviewed the current tools applied in the case company, namely the mail recipient database, delivery route optimization tool and cost calculation models. These current tools, although good, need to be used more efficiently. Third, this section analyzed the process mapping of the current mail delivery process, which contains the overview of productivity measurement, different roles and skills in delivery services, supply chain for the mail delivery services, and the existing vehicle system. Fourth, this section conducted the SWOT analysis of the existing mail delivery process. Strengths and threats have been identified, and the additional challenges for the postal sector were also discussed. These challenges include aspects of the new postal law, economic uncertainty and related risks, letter volumes and forecasts, the fact that consumer needs and delivery frequency have also changed, and finally the profitability of mail delivery business has changed by now.

Section 6 presented the proposal and recommendations for the improved mail delivery process based on the results of the analysis and interviews. It was concluded that the case company is undergoing hard times nowadays, as been told in many times in this study. Mail volumes are going down and the future shows also that there is no promise of a change for a while. The total delivery costs still remain too high and improvements for the process are necessary. The main business problem is that every working day mail has to be delivered to recipients, but the mail volumes are not well known beforehand. Statistical Reporting software in the case company is intended for managing mail volumes, which can bring about positive change. Additionally, the results of resource

allocation in standard working time with high costs will become available with the known mail volumes.

It was concluded that the cost structure of mail delivery in the delivery routes effects largely depends on population density. In the densely populated areas, delivery route optimization would play a larger role, because there is a lot of stops and drops along the mail delivery route. As mentioned earlier, the rate of the drops and stops is a very influential element for cost savings in the mail delivery process. In sparsely populated areas, the significance of delivery route length would be crucial and would affect significantly the costs of mail delivery. Coverage reports would become a valuable tool for the deliverers, because they would allow choosing a more cost effective way to move in delivery routes. And this will make the mail delivery services more effective overall.

7.2 Managerial Implications

This section presents the managerial implication for the case company. These implications are based on analysis and findings of this study.

1. Methods for productivity measurements need to be created based on the mail delivery objectives after critical inspection and acceptance, and observed very firmly. Higher level management needs to commit to the mail delivery objectives and clearly confirm to the personnel that activity will be based on objectives and methods. Otherwise the objective does not stay clear in mind in every activity levels and sectors.

2. The case company needs to measure productivity mostly against its own earlier features, because measuring against two different companies, and especially doing the right conclusions based on these features, is very difficult because of different operational environments.

3. The mail delivery services need to establish environmental and safety campaign to vehicle system, so that damages and accidents could be avoided. Also the upcoming driving style tracking devices need to be put into operation as soon as possible to follow which deliverers are not driving safely.

4. It is also necessary to investigate and analyze investments for projects. Managing load rate, costs of overwork, and the number of deliverers per delivery office. However, to allocate more resources to route optimization could possibly require starting a new project for this case.

5. A new plan for the unaddressed mail needs to be developed for deciding to outsource and confirm whether it is profitable in generally. It also needs to be taken account into account, if the new competitor could provide this service more efficiently and how the case company could cash on in that situation.

These managerial implications are formulated to support the suggested proposal and recommendations. For putting these into action, directors would need to start new projects. If the developed proposal of model for the improved mail delivery process is to be realized, the recommendations would need to be implemented part by part. As a follow-up for the study, this Thesis recommends also how to handle the additional challenges.

7.3 Reliability and Validity in This Study

This research is using qualitative and quantitative methods, qualitative methods for the interviews and quantitative methods for the data collection. These methods are not exclusively concerned with the action research, so that evidence is pulled from the data collection. This study is a combination of theoretical background, interviews for the current state analysis, data collection and making the proposals for the improved mail delivery process. With four and a half years of work experience in the case company, the researcher in this study is a specialist of the sorting technology also having knowledge of the mail delivery services. This current proposal of the model for the improved mail delivery process was verified with the researcher's boss, and he also expressed support for this model. The data from the case company research publications are official, and they have been published in the case company business intelligence.

7.4 Future Aspects

At the moment, there are 132 post shops, almost 850 post sales points, 50 SmartPOST parcel automatics and 11 pickup points in the post service point network nationwide. There are 3000 retail dealers, over 7000 yellow and blue letterboxes, and also home delivery and the so-called pickup mark service which make up the service network. In the future, the case company has plans to establish different service points of 1000 to 1500 by 2016. These plans will require a lot of improvements, commitment and further studies of mail delivery services efficiency.

Among the changes, it is, first of all, a new type of time period in post services. Now it is a critical period; after that, in the future, the mail volumes are going to be more electronic. As for the actual delivery of services, they will require better employee time management and better route management, which will be made possible through using various electronic statistical tools and improved measurements.

The current postal law stipulates that post office must be located in some fair way from a mail recipient permanent address; the law, however, does not specify exactly how far it could be located. To be efficient in the future, the availability of services must take into account human behavior and new needs of the customers. Such services will be able to offer better and more flexible, new solutions, besides the traditional postmen and post offices. It will be especially important for the case company to design such services so that they will not incur any additional expenses.

Behind the currently visible changes in the customers conduct and needs for new services, there are such tectonic societal changes as electrification of communication and a surge in electronic consumer and business commerce. The studies predict that the number of letters will further decrease but the number of mailing items will be growing steadily. Currently, 80% of interactions in the post offices are for picking up or sending parcels. And the studies suggest that people want easy, safe and fairly-priced services for sending and receiving parcels. Among the tangible mails, this will remain the leading service in the future as well, provided the needs of the customers are effectively addressed. The end of home address commitment will increase the options for the customers in terms of the cost for parcels.

As for the future electronic commerce market, the competition there is hard and will likely remain so, but the case company could still keep its first place there, due to its innovativeness and flexibility in this niche of the market.

Overall, in the future, the planned renewal of the service point network will bring about more cost efficient pickup points; and SmartPOST parcel automatics will become much more widespread and available all across Finland. Additionally, to achieve excellence, the collaboration with other service companies will need to increase. Being in close touch with service companies, post sales points may increase the service time and availability, thus eventually increasing the customer satisfaction with the services, especially concerning opening hours. The overall direction for the future is to leave it for customers to decide for themselves where and how they want to be served, and for the case company to fulfill these needs.

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Appendix 1. Interviews

Interview person 1: Development, Business Case

Could you give a short overview from the development of the mail delivery?

What are largest effects to delivery costs?

What different costs need to take account?

What are the market forecasts of mail volumes?

Which are the recommendations of improvements for the cost calculation model?

Interview person 2: Transport, Vehicles

Could you give a short overview from the vehicle system?

How this vehicle management system is working?

Which are the existing roles in the vehicle system?

What are the largest challenges managing the vehicle system?

Which are the recommendations of improvements for the vehicle system?

Interview person 3: Corporate Methods, Delivery Process

Could you give a short overview from the mail delivery process?

Which are the largest challenges in the resource allocating?

What are the existing roles in the mail delivery process?

Can you show the existing supply chain of the mail delivery process?

Which are the recommendations of improvements for the mail delivery services?

Appendix 2. Costs of Mail Delivery in Area 00770

Costs of mail delivery, Index = 1000000€, Delivery costs are 45% of all Postal Services			With GIS tool 20% of delivery points can leave without delivery (no mail)
Total delivery costs:	450000 €	Amount of omitted delivery points in route:	24
		Total omitted delivery points in route:	96
		Total omitted delivery points in 00770:	712
Amount of delivery routes = 7000 and 1000 of those are over 100km, these does not take account:	6000	Costs savings in 07700:	445,25 €
		Average costs / delivery route in 00770:	60 €
Average costs / delivery route:	75 €		
Average amount of delivery points in delivery route (densely populated area):	120		
		Delivery points in 00770 area after route optimization (February 2012):	2850
Delivery points in 00770 area (February 2012):	3562		
Delivery routes in 00770 postal code area:	30		
		Average costs / delivery point in 00770:	0,500 €
Average costs / delivery point:	0,625 €		
Total costs of 00770 delivery points:	**2226,25 €**	**Total costs after route optimization in 00770:**	**1781,00 €**

Appendix 3. Delivery Points, Sorting Codes and Oracle SQL Enquiry

SORTINGCODE	JAKTI_ID	ADDRESSOTSID	OTSADDRESSFAMILYID
0077010002	4448079	1346128	107586472
0077010002	4451999	1346128	107586472
0077010003	5214382	7204843	139457016
0077010004	276489	1346172	107586485
0077010005	4028403	1346154	130845151
0077010006	276486	3419073	132140197
0077010007	276485	3419075	132140207
0077010008	276464	1346132	112298218
0077010009	276484	1346170	112298386
0077010010	276465	1346146	112298276
0077010011	276482	1346152	112298302
0077010012	4452318	1346152	112298302
0077010013	276481	1346156	112298315
0077010014	276467	1346158	112298328
0077010015	276479	1346136	112298234
0077010016	276469	1346138	112298247
0077010017	276476	1346168	112298373
0077010018	276475	1346166	112298360
0077010019	276474	1346164	112298357
0077010020	276473	3419065	132140155
0077010021	276472	3419067	132140168
0077010022	276471	1346148	112298289
0077010023	4847298	6916910	137589355
0077010024	14887	977919	130689935
0077010025	4847299	6918876	137597075
0077010026	14884	977927	130689977
0077010027	5072121	6916919	137589397
0077010028	4377810	6916950	130778024
0077010029	3421331	1488822	113139745
0077010030	4519177	1488842	113139826
0077010031	3421333	1488826	113139761
0077010032	3421334	1488838	113139800
0077010033	3421335	1488828	130905460
0077010034	3421336	1488850	113139855
0077010035	3421337	1488830	113139774
0077010036	254486	3652475	132305466
0077010037	3421339	1488832	113139787
0077010038	4937492	1488846	113139839
0077010039	2209957	1488852	113139868
0077010040	2064759	356170	130420097
0077010041	3712345	356172	130420107
0077010042	2064758	1818666	131090400
0077010043	227965	1173428	106770658

ORACLE SQL ENQUIRY

```
select concat(sc.postdep,sc.calculatedcode) lajittelukoodi, dp.jakti_id, addr.addressotsid, af.otsaddressfamilyid
from sortingcode sc
join address addr              on sc.id                = addr.sortingcode_id
join deliverypoint dp          on addr.id              = dp.address_id
join addressfamily af          on addr.addressfamily_id = af.id
where sc.postdep in ('00770')
order by lajittelukoodi, jakti_id
```

HELSINKI

LSM Summary Report

Selected period : from 26/04/2012 06:00:00 to 27/04/2012 06:00:00

Consolidated by Day

Selection on

Machine nb 4

Sort plan 214 SS 00250 00320 0, 214 SS 00250 00320 0

		Operational time		Volume sorted	Reject counters: Out of sortplan reject	Reject counters: Others recycling rejects		V-Id™ No match	Sorted finalized		Outward OCR read rate		Sorting rate	
	Infeed items		Throughput	Sent to offline videocoding	Others manual rejects	V-Id™ match	V-Id™ matching rate	Sorted not finalized	Inward finalised OCR read rate		Sent to VCS			
Machine nb 4														
Sort plan 214 SS 00250 00320 00770 20.4.2012_PASS1														
26/04/2012	14 764	00:22	38 739	14 567	0	146	51	119	11 463	1 869	86,0%	14 363	85	98%	89%	99%	0
Total Sort plan 214 SS 00250 00320 00770	14 764	00:22	38 739	14 567	0	146	51	119	11 463	1 869	86,0%	14 363	85	98%	89%	99%	0
Sort plan 214 SS 00250 00320 00770 20.4.2012_PASS2														
26/04/2012	14 416	00:38	22 302	14 280	0	11	125	41	14 010	382	97,3%	14 217	22	98%	90%	99%	0
Total Sort plan 214 SS 00250 00320 00770	14 416	00:38	22 302	14 280	0	11	125	41	14 010	382	97,3%	14 217	22	98%	90%	99%	0
TotalMachine nb 4	29 180	01:01	28 399	28 847	0	157	176	160	25 473	2 251	91,9%	28 580	107	98%	90%	99%	0
Total	29 180	01:01	28 399	28 847	0	157	176	160	25 473	2 251	91,9%	28 580	107	98%	90%	99%	0